APPENDIX K:

ANALYSIS OF THE USE OF ZERO-LIQUID DISCHARGE TECHNOLOGIES AT THE POWER PLANTS IN MEXICO

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Zero-discharge technologies were investigated as a possible wastewater management alternative technology to reduce impacts to the New River and Salton Sea from the La Rosita Power Complex (LRPC) and Termoeléctrica de Mexicali (TDM) power plants. Implications for the installation and operation of such a technology are discussed in detail below. The potential impacts on salinity and other water quality measures resulting from installation of the technology at both plants are also presented.

Zero-discharge water management systems for steam electricity-generating stations have historically been applied in areas that are deficient in water supply, remote from suitable receiving streams for wastewater discharge, and/or at projects seeking to streamline their licensing schedule (Kasper 2004). With zero-discharge plants, an attempt is made to minimize wastewater production, reuse as much wastewater as possible within the plant, and employ evaporation to eliminate the remainder of the wastewater produced. In the discussion presented below, the technology is considered mainly as a means of reducing discharges of total dissolved solids (TDS) from the LRPD and TDM power plants to the New River.

Cooling systems are typically the major users of water at power plants. Open recirculating cooling systems employing cooling towers (such as those at the LRPC and TDM power plants) require makeup water for losses due to evaporation and blowdown (water that must be removed from the system on a regular basis in order to maintain proper chemical conditions and efficient operations). Blowdown of water in the recirculating cooling system is required to mitigate corrosion of system materials and to prevent scaling on heat exchanger surfaces. Cooling tower blowdown is typically the largest wastewater stream in a combined-cycle power plant. Other, smaller streams of wastewater may include wastewater from the treatment process, floor and equipment drains, heat recovery steam generator blowdown, and evaporative cooler blowdown.

If there is sufficient space on site and if local meteorological conditions are favorable for evaporation, the most cost-effective method of achieving zero-liquid discharge is to dispose of all the wastewater to solar evaporation ponds. Where space is unavailable, land is too costly, or areas have net annual precipitation, mechanical evaporators are employed to remove the wastewater. Evaporator distillate can be recovered as feedwater to the makeup demineralizer system or as partial cooling tower makeup (makeup water is water that is used to replace water that has been removed by design from the system through blowdown and evaporation and other system losses). Evaporator concentrate must be further processed to remove water vapor in a spray dryer or crystallizer. The resultant solid salts of the processes are trucked off site for disposal.

Economics dictate that the flow of wastewater to evaporation ponds or mechanical evaporators be minimized because the construction, operation, and maintenance of ponds and mechanical evaporators can be expensive. Typically, cooling tower systems are run at more than one cycle of concentration (i.e., the number of times that the water is reused in the system) in order to minimize blowdown discharge (four to five cycles are employed at the LRPC and TDM power plants). Low-concentration soluble salts in the cooling water are problematic for power plants and must be controlled by using sidestream lime softeners and/or membranes. Very often, chemicals added for cooling system maintenance, such as scale inhibitors and dispersants, conflict with the chemical conditions that need to be maintained in the softener. Low-concentration soluble salts are precipitated in the softener, and the resultant sludge must be dewatered and properly disposed of.

The design of a successful zero-discharge management system is complex, as is its operation. It is influenced by space limitations, water quality, degree of operator attention, system materials, and other variables. It is challenging enough to design a successful zero-discharge system when such a design is the original intent. To modify an existing plant, such as the Energiá de Baja California (EBC) plant at LRPC, to a zero-discharge design would impose formidable challenges that might or might not be successfully addressed.

A zero-discharge system requires that control systems be modified and expanded to allow plant operators to base decisions on real-time data for wastewater stream flows and storage tank inventories. Intermediate wastewater storage tanks must be added to provide buffers in case of downstream mechanical equipment failures. For instance, it is common practice to install a single mechanical evaporator train rather than redundant trains because of the significant capital costs incurred. Most evaporator suppliers recommend that 7 days' storage of wastewater be provided upstream to allow for equipment repair and/or replacement. For example, if sidestream treatment to reduce cooling tower blowdown was proven to be infeasible at EBC, a storage pond or tank with a capacity of approximately 4,490,924 gal (17,000 m^3) would be required (Kasper 2004). The complexity of a zero-discharge system requires that the power plant hire additional operating staff to monitor and manage its operation. Similar issues and requirements would be expected to apply at the TDM plant.

In addition to the design and operational complexities discussed above, the benefits of installing zero-discharge systems at the power plants would be questionable. Table K-1 shows the concentrations for TDS, total suspended solids (TSS), biochemical oxygen demand (BOD), chemical oxygen demand (COD), phosphorus (P), and selenium (Se) at the Calexico gage at the U.S.-Mexico border for no plants operating, the LRPC and TDM power plants operating simultaneously at 100% power, and the LRPC and TDM plants operating at 100% under a zero-discharge limit. For the zero-discharge limit scenario, the power plants are assumed to draw a total of 10,667 ac-ft/yr (0.41 m^3/s) of water from the lagoons. This value is consistent with the total consumptive water use for both plants operating (Section 4.2.4). Water required under the proposed action (13,387 ac-ft/yr) (0.52 m^3/s) includes blowdown water for the cooling towers. This water would not be required for the zero-discharge limit scenario.

The calculations show that a zero-discharge scenario would produce both beneficial and adverse mixed water quality impacts at the U.S.-Mexico border relative to both the LRPC and TDM power plants operating under normal (i.e., wet cooling) conditions. Concentrations of TDS

TABLE K-1 Estimated Concentrations of Various Constituents in New River Water as a Result of Installing Zero-Liquid Discharge Technology at the Power Plants

	Concentration (mg/L) in the New River at the U.S. Border			Concentration Changes Resulting from Use of Zero-Liquid Discharge Systems at Both Power Plants	
Constituent	No Plants Operating	Proposed Action	Zero-Discharge	Change Relative to Proposed Action (mg/L)	Change Relative to Proposed Action (%)
TDS	2,620	2,766	2,709	–57	–2.1
TSS	52.7	51.5	52.3	0.8	1.6
BOD	27.5	25.9	26.5	0.6	2.3
COD	53.6	44.5	46.8	2.3	5.2
P	2.0	1.85	1.9	–0.05	–2.7
Se	0.021	0.022	0.022	0.0	0.0

would decrease by about 2%, thereby providing a beneficial impact, while the concentrations for TSS, BOD, COD, and Se would slightly increase; COD would increase by more than 5%. Flows to the New River would be reduced slightly compared with both plants operating under normal wet-cooling conditions because of the elimination of wastewater discharges from the plants.

In conclusion, not only would the retrofit of zero-discharge systems to the power plants prove technically challenging and incur higher capital and operating costs, as discussed above, it would also produce very minor water quality benefits to the New River. Therefore, the impacts of this technology are not evaluated further in this environmental impact statement as a reasonable alternative technology for Alternative 3.

APPENDIX K REFERENCE

Kasper, J.R., 2003, "Results of Analytical Sampling of Gray Water, Effluent, and Influent for the Zaragoza Oxidation Lagoons," personal communication from Kasper (Aquagenics, Inc., Woburn, Mass.) to K. Picel (Argonne National Laboratory, Argonne, Ill.), Dec. 9.